Designing cost effective auctions as instruments to reduce nutrients run-off from agriculture into the Baltic Sea - an experimental study

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ABSTRACT. This research studies the use of auctions for reducing leaching of phosphorus and nitrogen into the Baltic Sea. Auctions are introduced as a tool for creating environmental contracts in agriculture for the first time in Finland. A controlled laboratory experiment is used to analyze the effect of introducing a bundle mechanism in the auction. Landholders submit sealed bids on multiple parcels in a one shot reverse auction. Each parcel is assigned an environmental quality and varies in size. In one treatment landholders can offer bids on environmental contracts for their parcels individually. In the other treatment landholders are given the opportunity to bundle parcels of land together when submitting bids as well as submitting bids for individual parcels. The results suggest that the bundle mechanism increase environmental efficiency of the auction compared to the individual parcel auction. In the treatment with individual parcel bids environmental value significantly affects over half of landholders' offers. The bundle treatment however shows sign of a cognitive bias where landholders use the hectare size to determine their offers.

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Introduction

Non-point source pollution continues to constitute a problem for the Baltic Sea with agriculture accountable for 50% of total nitrogen and phosphorus load into the Baltic Sea (HELCOM 2010). Unfortunately the current instruments are inadequate and there is an immediate need for more efficient environmental programs for agriculture.

Auctions have become a main tool when creating environmental contracting. Environmental contracts in agriculture often involve asymmetric information between the program administrator and the owners of the land as the farmers have more information regarding the risk and cost of participation in the program. In addition the goods traded are non-market goods with no standard value (Latacz-Lohmann, 1997). Auctions provide a tool for dealing with the uncertainty about the goods being traded as it is the farmers who provide the asking price. Farmers offer their environmental service together with their bid (requested compensation) and competition between the farmers yield incentives to bid closer to the actual cost. The effect of competition on the size of the bids increase total environmental benefit achieved within the conservation budget compared to non-auction based environmental policies.

The Conservation Reserve Program (CRP) in the U.S. has since 1986 allocated land retirement contracts on the basis of competitive auctions. More recently auctions have been implemented in agriculture in programs like the Bush Tender programs in Australia and irrigation permits in the U.S.A. Moreover, auctions are used in forestry such as in the Woodland area project in the U.K. and the Conservation Contracts for Forest Biodiversity in Finland (Juutinen and Ollikainen, 2010).

The difference between the actual cost and the size of a bid is called information rent and accounts for the farmers' profit. The challenge of the auction is to include mechanisms that will encourage farmers to decrease the bids even closer to the actual cost, minimizing information rent and allocate the information rent into environmental benefit. Experiments can help improve the performance of the auction by identifying mechanisms that minimize information rent. Well designed auctions are essential for maximizing environmental benefit and for the farmers to accept the auction as fair and intuitive.

Experimental Economics provide a tool for testing different aspect of an auction design in a simple controlled environment before the auction is implemented and by doing so it reduces the chance of costly mistakes of the auction design. Consequently research in experimental economics can offer an important contribution to the effective design of policies of environment and resource allocation. The last 10 years experiments have become increasingly popular when designing policies for the

environment and allocation of resources (Ostrom, 2010 and Reeson and Tisdell, 2008) and more specifically in auctions for agriculture by Cummings et al. (2004) and Cason et al. (2003). Experiments are typically conducted in a laboratory with real economic incentives. In the laboratory the researcher can isolate the signals the participants receive and thus identify the response to a particular economic incentive by comparing different designs.

In the autumn of 2010 Agrifoods Finland (MTT) ran a framed field experiment with farmers in an area north of Helsinki in Finland. The farmers participated in an auction using a bundle mechanism where they were able to submit bids for bundles of parcels as well as bids for individual parcels. The bundle mechanism proved to be popular with the farmers. 9 farmers participated and the farmers who got their bids accepted signed an environmental contract involving spreading of Gypsum on their land. Gypsum binds phosphorus in the ground and thereby reduces run-off into waterways.

We decided to test the bundle mechanism in the experimental laboratory assess how it affects the bidding behavior, information rent and the efficiency of the auction. Although the bundle mechanism is a very intuitive auction design for the farmers it has not, to our knowledge, been implemented in any agri-environmental auction prior to this study.

The experimental design

The experiments will be conducted over the winter and spring of early 2011. This paper reports on the first 3 sessions. We run two treatments. In treatment one (T1) the landholders can submit bids for individual parcels only. In treatment two (T2) landholders can bundle parcels together and also submit bids on individual parcels. Each landholder is assigned one of five types of farmers. Each farmer has 10 parcels with sizes ranging from 1-8 hectares. Each parcel is assigned an environmental value ranging from 8-66 drawn from a distribution matching the environmental value from the area in Finland where the framed field experiment took place. The environmental value was calculated using three variables; proximity to waterways, phosphorus value in the ground and slope of the parcel. The cost of spreading Gypsum was approximately linear in hectares replicating the cost of the framed field experiment. The same five types of farmers were used in both treatments to limit cross treatment variations. Treatment one was conducted in one session with 21

students and there are two sessions of treatment two, one with 13 students and one with 21 students. The experiment was programmed and conducted with the software z-Tree (Fischbacher 2007).

The auction was played for one round as spreading of Gypsum will take place only every 5 years and the auction will vary in number of participants and potential changes in how the environmental value is calculated from period to period. These changes will make it complicated for farmers to use information regarding last periods accepted offers in a meaningful way. One shot or repeated auction. There is a tradeoff between gaining confidence from the farmers by repeating the auction and the farmers learning the price and increasing their bids (Latacz-Lohmann and Van der Hamsvoort, 1997).

A discriminatory price rule was implemented as this is considered most fair by participants and will not automatically exclude high environmental value parcels from being included in the winning bids. In multiple unit auctions there are typically two ways of paying the winners, discriminatory price and uniform price. When winners are paid the same amount as their bid the price is discriminatory. On the other hand with a uniform price the price of the highest bid that is accepted forms the payment level and all landholders with lower bids will be paid this same amount independent of their initial bid. In standard auction theory uniform pricing should encourage participants to reveal their true value of the good and thus be recommended over the discriminatory price. Agri-environmental auctions however have several mechanisms that make it difficult to predict which pricing rule is more efficient. Experimental tests show that in agri-environmental auctions discriminatory price in recommended (Cason and Gangadharan (2004)) as the uniform price auction results in overcompensation for parcels with low environmental value and at the same time exclude parcels with high environmental value, the parcels of highest interest to the regulator. The uniform price might also lead discontent from farmers as all landholders get the same price if accepted independent of environmental value.

Participants know their own cost, parcels and environmental value, but have no information regarding the parcels and environmental value of other participants. Revealing the environmental value of the participants' own parcels can increase the bids for high index parcels and therefore lead to lower total environmental benefit than in the case where the environmental value is not revealed. The high index parcels are often the target of an environmental program and thus this is a negative effect of complete information regarding the environmental value (Cason et al., 2003). However, revealing the environmental value of the parcels might increase perceived fairness and transparency

and give farmers who have preferences for the environment an opportunity to target environmental projects to the most beneficial parcels (Cason et al. 2003).

This paper focus on the bundle mechanism and how it affects bidding behavior and the efficiency of the auction. In treatment two (T2) participants were allowed to create two bundles and submit bids for these bundles and at the same time submit bids for individual parcels. When the landholders take transaction cost into account he/she might find that there is a lower limit to the hectare size of an environmental contract. Therefore the farmers have the opportunity to offer bids for bundles of parcels. The parcels do not need to be neighboring parcels but it is in the farmers own interest to minimize the costs and take advantage of economies of scale of his bundles. A single parcel could be offered both as an individual parcel and also as a part of a bundle. In both treatments all bids were ranked by the environmental value for the price/bid, with the highest environmental valued for bid accepted first and then the second highest until the budget was exhausted. A parcel could not be accepted both individually and in a bundle so if the highest ranked bid for a particular parcel would be accepted, then other bids including that particular parcel would be deleted from the auction.

The bundle mechanism has proven to be popular when the auction was tested farmers in the laboratory and in a field experiment. This is important as it might increase the auctions popularity with the farmers if it is more intuitive.

A budget constrained auctions rank the bids and buys the cheapest until the budget is exhausted. A target constrained auction ranks the bids and buys the cheapest until a certain volume is reached. If there is no budget constraint, and competition is weak the prices could increase to highly inefficient levels. In a case like that it would be essential to have a reservation price. The auction analyzed in this paper is a budget constrained auction.

The subjects were undergraduate students from University of Helsinki. It was not possible for the participants to communicate during the experiment. Collusion is an important factor in agri-environmental auctions but as this was not the focus of this particular experiment, we did not allow it.

Results

The preliminary results from the first three sessions indicate that in T1 for 60% of participants the size of information rent is significantly affected by the environmental value of the parcel. For no participants was the information rent significantly determined by the hectare size or cost in T1. In

T2 however, 22% of participants the information rent was significantly affected by the environmental value of the parcel. More surprisingly, for 61% of the participants the hectare size of the bid significantly affected the information rent. This might be due to cognitive bias where the bundle mechanism complicates the auction and participants choose to bid according to a cognitive bias where the hectare size in dominating.

When the market performance is analyzed using the performance measures from Cason et al. 2003 we find that the bundle mechanism is more efficient than when no bundle in allowed. The table below shows the performance measures for the two treatments:

	T1 (no bundle)	T2 (bundle)
P-MAR	86%	94%
P-OCER	88%	93%
Seller's profit	1490	1158

P-MAR is the percentage of maximum abatement realized.
P-OCER is the percentage of optimal cost-effectiveness realized
Seller's profit is the part of the budget allocated that represents information rent.

Discussion

The first sessions run testing the bundle mechanism show that introducing the bundle mechanism might improve the environmental efficiency of the auction. Whether this result is robust and what bidding behavior lies behind these results will be analyzed over the next months by running more experiments with both students in the laboratory and also with farmers by mail using incentives.

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